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Peroneal artery-vein index as a potential factor of thrombosis occurrence in free osteocutaneous fibula flap

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ABSTRACT

Background: Despite high popularity and great success rates of free osteocutaneous fibula flaps, the flap failure caused by vascular thrombosis is still a challenging problem.
The authors present their evaluation of a potential thrombosis risk factor – a peroneal artery-vein index.
Methods: The authors evaluated the diameters of peroneal vessels and peroneal artery-vein indexes based on the computed tomography angiographies in 10 patients who underwent a mandible reconstruction with a free fibula flap and compared the results with clinical outcome.
Results: In one case the flap was lost, because of thrombosis in the donor vein. This patient presented superficial varicose veins of both lower extremities. Peroneal vein diameters in this patient ranged from 5,05 mm to 6,68 mm and were higher than in patients without complications. The peroneal artery-vein index in the patient with thrombosis ranged from 0,37 to 0,50 with median 0,40 and was lower than in patients without complications.
Conclusions: High disproportion between peroneal artery and concomitant veins might be a potential risk factor of the occurrence of venal thrombosis. Detailed perioperative examination of peroneal veins in patients with varicosities should be considered.

1. Introduction

The first use of a free fibula flap was reported in 1975 by Taylor, but the first series of free fibula flaps for mandible reconstruction was published in 1989 by Hidalgo (Taylor et al., 1975; Hidalgo, 1989). Nowadays this method is considered to be a method of choice not only for mandibular reconstruction after ablative tumor surgery or facial injury, but also for reconstruction of complex defects in extremities (Pototsching et al., 2013; Hidalgo and Pusic, 2002; Wong and Wei, 2010; Sadove et al., 1993; Papadopulos et al., 2002).

Due to its anatomical features it has very significant advantages in mandible reconstruction such as: long pedicle, consistent shape, distant location to allow two-team approach, enough bone length (ca. 25 cm) to restore any mandibular defect and also, the periosteal blood supply allows to perform many osteotomies without damaging the blood supply (Hidalgo, 1989; Pototsching et al., 2013; Bepp et al., 1992; Jones et al., 1996; Wei et al., 1986). This flap also allows placing osseointegrated implants and dental rehabilitation (Chang et al., 1998; Cebrian-Carretero et al., 2014).

Despite high popularity and great success rates of 87–96% anastomosed vessel occlusion is still a serious complication resulting in flap failure when not detected in time (Mueller et al., 2012; Brands et al., 2010; Dassonville et al., 2008; Chen et al., 2008). Clinical signs are not always visible and are hard to detect which causes a delayed diagnosis of flap failure initiation and revision of the anastomosis (Mueller et al., 2012).

Nowadays in flap monitoring many methods are used, such as: visual exam, pinprick, Doppler signal, color Doppler, The Cook-Swartz Doppler, Flow Coupler (Synovis Life Technologies, Inc.), luminescence ratiometric oxygen imaging (LROI) and contrast-enhanced ultrasound (CEUS) (Mueller et al., 2012; Kempton et al., 2015; Spiegel and Polat, 2007; Um et al., 2014).

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Higher risk of thrombosis occurs with chronical diseases such as hypertension, diabetes or atherosclerosis, and also increasing age (>65) is reported as a risk factor (Stavrianos et al., 2003; Valentini et al., 2008; Borggreven et al., 2003; Mitchell and Sidawy, 2005). It is also mentioned that good surgical technique and proper patient selection may reduce the risk of thrombosis (Froemel et al., 2013).

To reduce the possibility of flap loss, there is a need to develop better methods of postoperative monitoring and to determine risk factors of thrombosis.

The aim of this study was to analyze diameters of peroneal arteries and veins with evaluation of a peroneal artery-vein index (PAVI) based on computed tomography angiography (CTA) performed in patients prior to mandible reconstruction with osteocutaneous free fibula flaps and comparing the results with clinical outcome.

2. Materials and methods

Ten patients underwent a mandible reconstruction with a free osteocutaneous fibula flap in the Department of Maxillofacial and Plastic Surgery Medical University of Bialystok between January 2013 and November 2015. Segments of the flaps remained vascularized by careful conservation of the periosteal attachment and the accompanying vessels. In 90% (9 patients) the donor site was non dominant leg (left). The bone segments were fixed to the remaining mandible with a Reconstruction Plate (Synthes®). In each case, the peroneal artery was anastomosed to the superior thyroid artery or the facial artery and one of the peroneal veins was connected to the branches of external or internal jugular vein. Single venous anastomoses were performed in all cases by the same surgeon. Nine patients were male and one female. Only in one patient a thrombosis in new anastomosis occurred. In this patient in preoperative examination varicose veins in both lower extremities were revealed. As it was considered to be only a superficial varicosities, the patient was qualified to the surgery. The donor site was the dominant leg of the patient, because of more reliable perforators for a flap than in the left extremity. During the operation a disproportion between peroneal artery and peroneal veins was observed. In this patient standard thrombosis prevention – enoxaparin sodium (Clexane) 0.4 ml s.c. starting on the day before surgery and 7 days after postoperative and hydroxyethyl starch (HAES 10%) 500 ml postoperatively – was used. The flap was observed postoperatively by color, temperature, pinprick and signal Doppler examination every two hours during the first 3 days after the surgery. Symptoms of thrombosis were noticed 5 days after the surgery (dark color and exultation of the skin island, the flap artery and vein were unavailable in Doppler examination) and the revision of the anastomosis was performed that day. During the surgery a clot from the flap vein was removed and the anastomosis was rinsed with heparin. Normal blood flow was obtained. After the revision, flap color became more pallor and warm, and the flap vessels were detectable in Doppler examination. Two days later clinical signs of thrombosis occurred again. CTA performed that day showed thrombosis of the flap vein, and the flap was removed two days later (4 days after the revision). It bears mentioning that the patient went on smoking 30 cigarettes per day even perioperatively.

Before microsurgery all of the patients had performed a CTA of the lower limb vasculature, with the anatomical details of the peroneal cutaneous perforators assessed. All the patients were consecutively investigated using a 64-slice MDCT (Toshiba's Aquilion CX, Tokyo, Japan). The scans were acquired in a cranio-caudal order. The area evaluated was between the suprarenal aorta and the tip of the foot. The scanning parameters were set as follows: tube voltage: 120 kv, mA – Auto Exposure Control, table speed: 29 mm/s; pitch: 0.844 mm; thickness: 1 mm, and reconstruction interval: 0.8 mm. A helical pitch of 23 (table speed 46 mm/s) results in an acquisition time on the order of 25 s for an average size adult. Contrast medium was injected at 5 ml/s.

To achieve optimal contrasting in the vascular structures, automatic bolus tracking (SureStart) was used to determine the delay time. The region of interest (ROI) was placed in abdominal aorta above the level of the renal artery orifice. While monitoring the contrast bolus, scanning was automatically started when the density in the abdominal aorta reached the level of 180 HU. In the first stage, the abdominal aorta to the feet level was scanned, and in the second pass the area from feet to the level just above the knees was evaluated. For each patient, 80–100 ml of contrast material was used. The contrast material (400 mgI/mL) was infused in dualphasic fashion at a rate of 4 ml/s, followed by flushing with 40 ml saline solution.

The images were processed on a separate workstation with multiplanar reconstruction (MPR) and volume rendering reformations (VRT), image reconstructions were achieved with Vitrea Software (Vital Image Inc, Plymouth, Minn).

This software allowed us to measure the diameter of peroneal arteries and peroneal veins and calculate the artery-vein index – peroneal artery diameter divided by peroneal vein diameter. Because of lack of the late phase in CTA, the measurements of the veins were performed based on the differences in attenuation between veins filled by blood and fat which surrounds them (fat −100 to −50 in Hounsfield scale, blood +30 to +45 HU). Measurements of the vessels diameter were taken in the middle of a line connecting head of fibula and lateral malleolus (±3 cm). Figs. 1 and 2.

When the lumen of vein was closed or its shape was oblate the measurements were performed with the use of elliptic or curvilinear ROI and the diameter was counted based on the surface of the vessel – πr^2. All measurements were performed by the same person (Fig. 3).

3. Results

The measurements showed that diameter of peroneal artery ranged from 2,3 mm to 4,0 mm with median 3,05 mm (Fig. 4).

There were no significant differences between left and right peroneal artery.

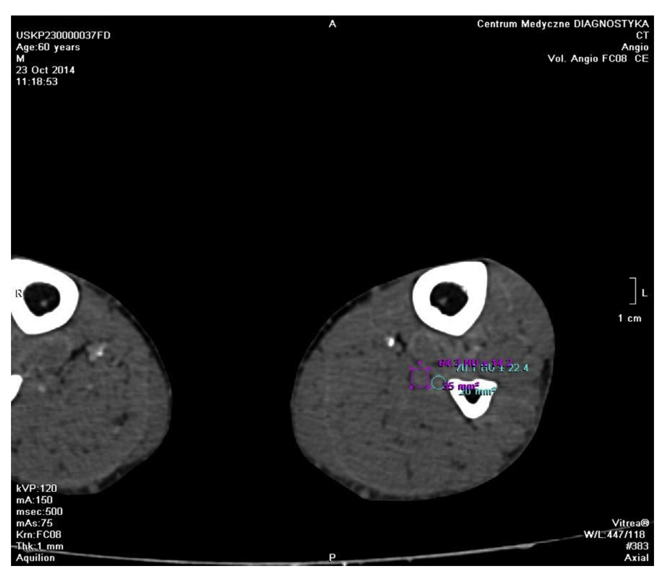

Fig. 1. Measurements of the left peroneal veins surface.